Mosquito Control Capabilities in the U.S.

October 2017

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Background & Methods

Mosquito-borne diseases are a constant public health concern in the United States. Zika virus (ZIKV) is a mosquito-borne virus spread to humans mainly through the bite of infected *Aedes aegypti* mosquitoes. The related *Ae. albopictus* mosquito can support ZIKV transmission in laboratory studies, so far.[1] Both mosquitoes inhabit a large portion of the U.S.

West Nile Virus (WNV), another mosquito-borne virus, is spread through the bite of infected *Culex* species mosquitoes. *Culex* mosquitoes can be found throughout the U.S., and WNV cases have been reported in every state within the continental U.S.

While local health departments and other local agencies are on the front lines of defense against ZIKV and WNV, almost no data exists on whether or not local agencies are prepared for a mosquito-borne virus outbreak. Without this information, federal and state efforts to support local response needs and address capacity gaps are significantly limited.

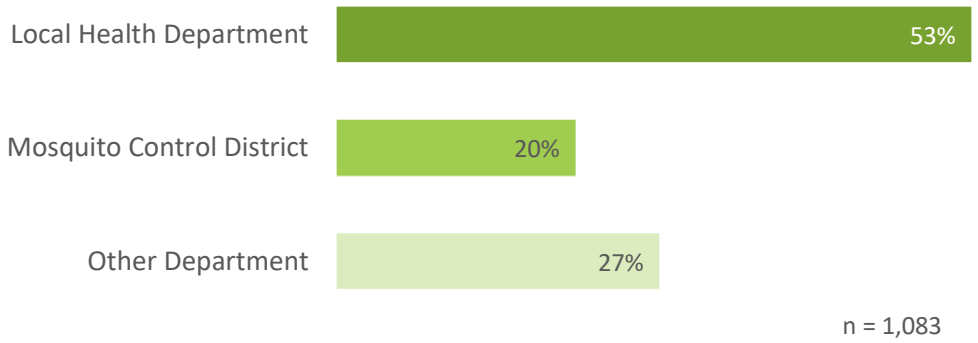
The Mosquito Surveillance and Control assessment was sent to the 1,906 vector control organizations in the U.S., representing all organizations identified by the Centers for Disease Control and Prevention (CDC), the American Mosquito Control Association (AMCA), and the National Association of County and City Health Officials (NACCHO).

A total of 1,083 vector control organizations completed the assessment for a 57% response rate.

Each vector control organization self-verified ongoing activities.

The assessment included 10 questions and was distributed online via Qualtrics Survey Software™.

Respondents represent vector control programs from different organizations across the United States



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Mosquito Surveillance and Control Assessment and Ranking

Definitions

A **Fully Capable** vector control organization performs all core and supplemental competencies.

A **Competent** vector control organization performs all core competencies.

A **Needs Improvement** vector control organization fails to perform one or more core competency.

A scoring matrix was created to prioritize or weight questions based on necessary capabilities of a competent vector control program. Using the CDC framework[2,3] for vector control competency as guidance, five core competencies were used to rank each organization as **Fully Capable**, **Competent**, or **Needs Improvement**.

Core Competencies

1. Routine mosquito surveillance through standardized trapping and species identification
2. Treatment decisions using surveillance data
3. Larviciding, adulticiding, or both
4. Routine vector control activities (e.g., chemical, biological, source reduction, or environmental management)
5. Pesticide resistance testing

Supplemental Competencies

6. Licensed pesticide application
7. Vector control activities other than chemical control (e.g., biological, source reduction, or water management)
8. Community outreach and education campaigns regarding mosquito-borne diseases, how they spread, and how to prevent infection
9. Regular communication with local health departments regarding surveillance and epidemiology
10. Outreach (e.g., communication and/or cooperation) with nearby vector control programs

Vector Control Organization Competency

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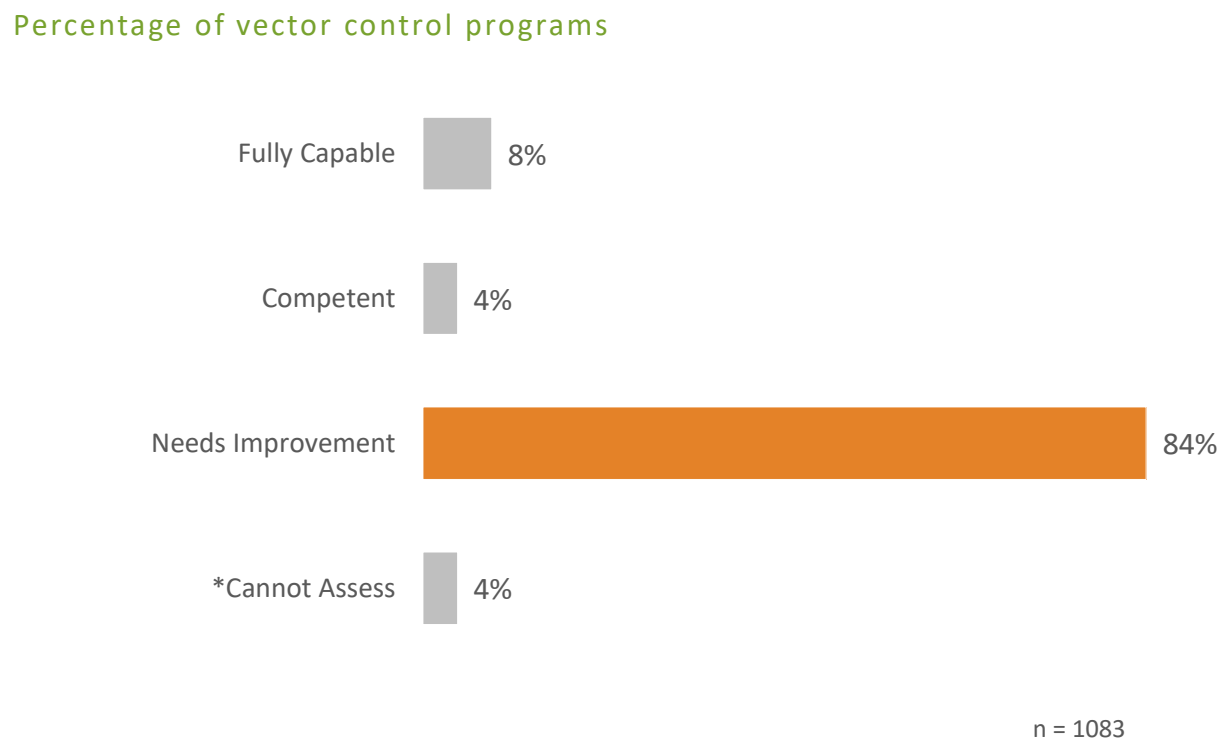
The overwhelming majority of vector control programs are in need of improvement

The assessment revealed that, based on the standards for competency developed and promoted by CDC and AMCA, **84% of respondents are in need of improvement** in at least one core competency area.

*Partially completed assessments were included for data analysis but could not be ranked for competency.



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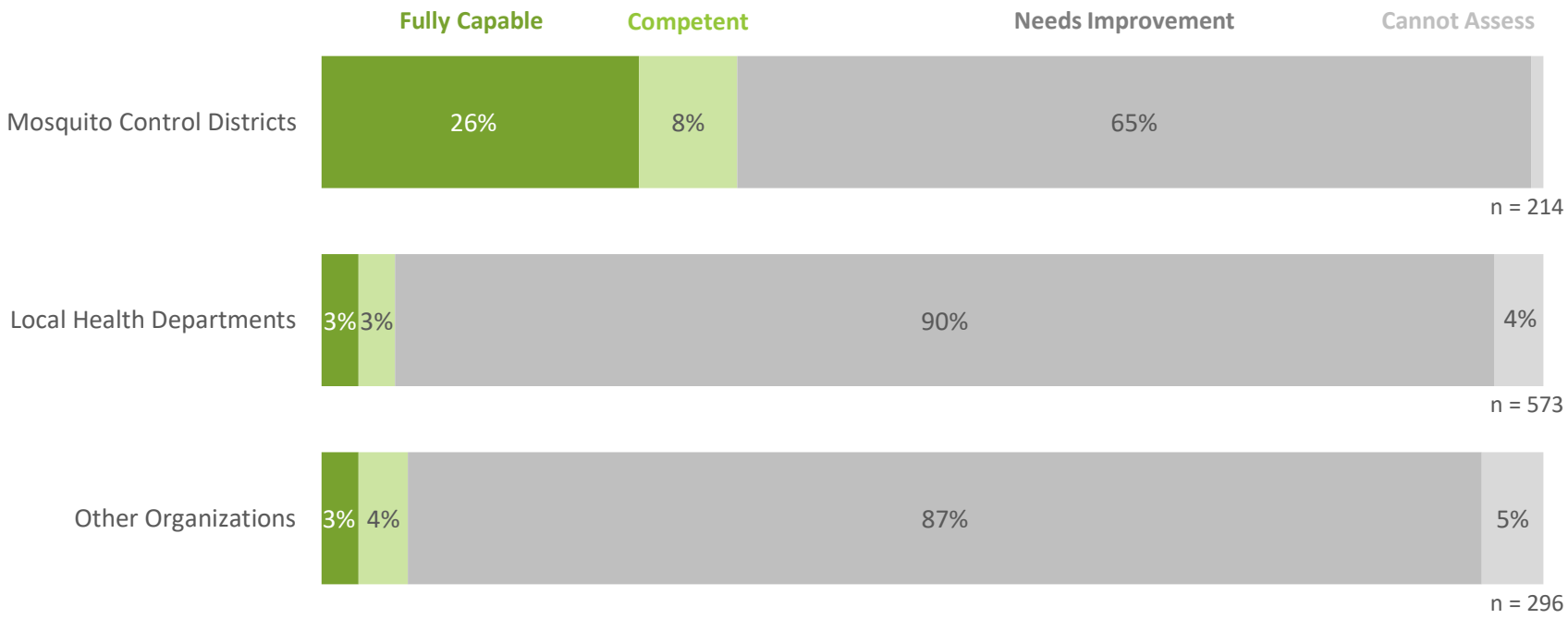
The level of vector control competency varies by organization type

Vector control programs are carried out by a variety of organizations across the U.S. Overall, they can be classified into three categories: **Local Health Departments**, **Mosquito Control Districts**, and **Others**.

"Other" includes a variety of city/local governmental agencies (e.g., public works departments, street and sanitation departments, Tribal networks, environmental health services, parish police juries, parks and recreation departments, weed and pest departments, and utilities departments).

These results reveal differences in mosquito surveillance and control capabilities based on organization type. For example, **mosquito control districts outperform** both local health departments and other city or local governmental agencies.



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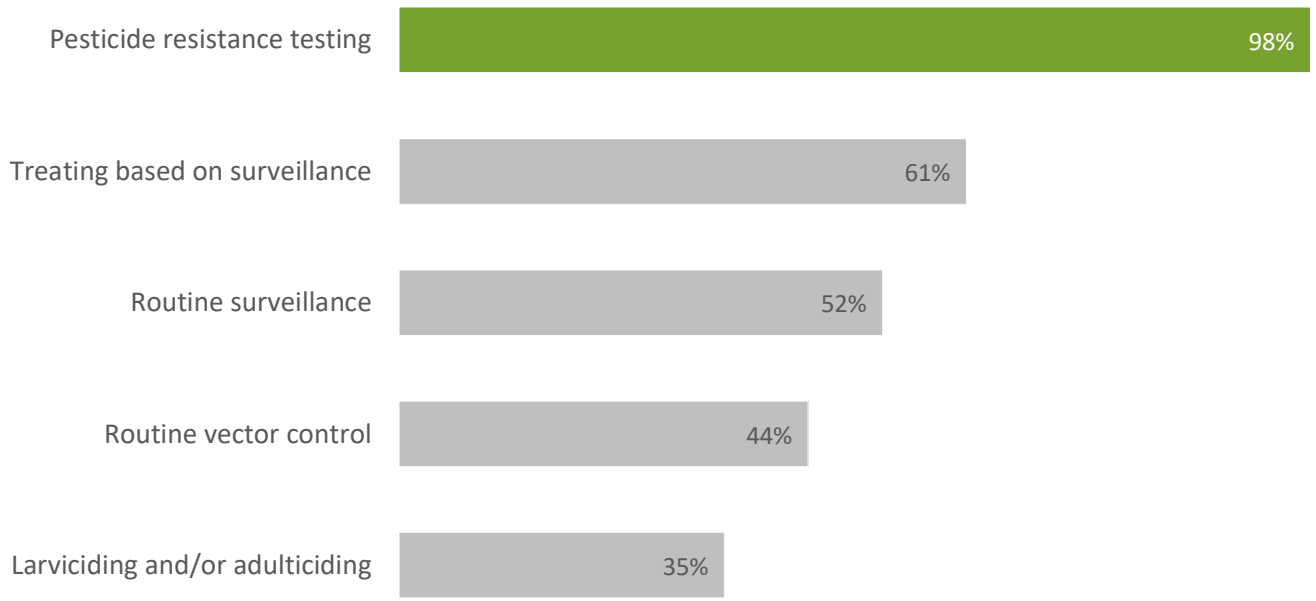
Pesticide resistance testing is the greatest competency gap for vector control programs

Of the vector control programs ranked as **Needs Improvement**, nearly all of them (98%) lack the capability or capacity to perform pesticide resistance testing.

More than half of these programs also lack competency in performing routine surveillance and species identification. Furthermore, gaps in competency exist related to using that surveillance data to make treatment decisions.

Percentage of "needs improvement" vector control programs lacking each core competency



n = 914

Core Competencies Performed by Vector Control Organizations

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Routine standardized surveillance is NOT ROUTINE for all vector control programs

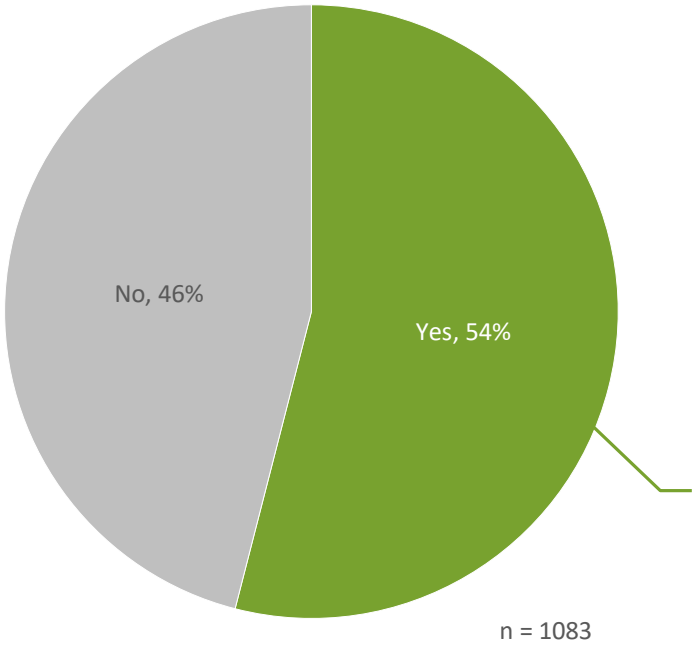
Mosquito surveillance involves species identification, abundance, and spatial distribution within a geographic area through the collection of eggs, larvae, and adult mosquitoes. It is necessary for:

- Monitoring changes in abundance and species distribution;
- Evaluating control efforts; and
- Informing intervention decisions.[4]

46% of programs do not perform routine standardized surveillance.

Of those that do perform routine surveillance, 15% reported NOT using this information to inform mosquito-borne disease treatment decisions.

Percentage of vector control programs conducting routine surveillance for mosquitoes



Of these, 85% of vector control programs reported using the information gathered to make treatment decisions.

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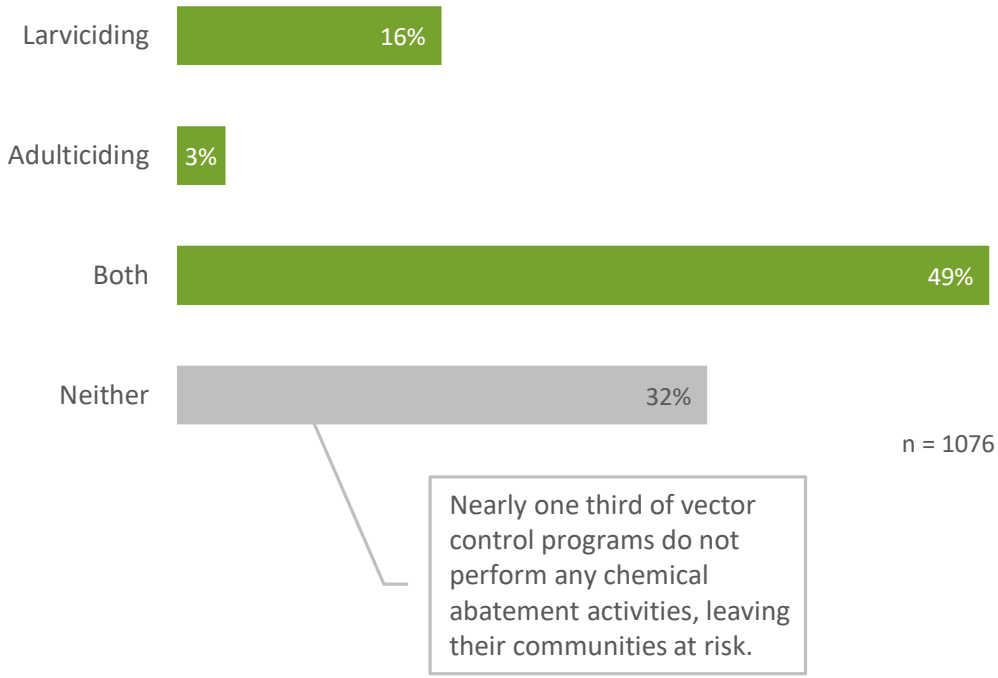
Chemical mosquito abatement is performed by most vector control programs

Larvicides (biopesticides and chemicals) inhibit the growth of mosquito larvae thereby reducing the number of adult mosquitoes in a given area.

Adulticides (insecticides) are toxic to mosquitoes, killing them via direct contact. Surveillance data is critical to justify the use of adulticides.

Chemical abatement using larvicides, adulticides, or a combination **is performed by the majority (68%) of vector control programs.**

Percentage of vector control programs conducting larviciding and/or adulticiding



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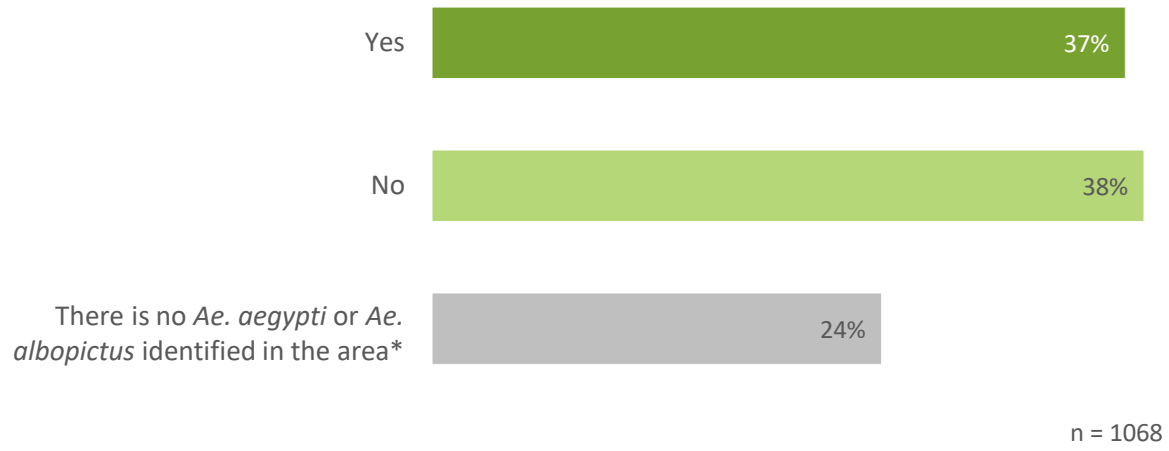
Routine species-specific mosquito control is NOT ROUTINE for all vector control programs

Species-specific vector control activities are not performed uniformly across the U.S. **38% of programs do not perform routine species-specific vector control**.

Routine species-specific vector control includes chemical, biological, source reduction, and/or environmental management activities tailored to the breeding and feeding habitats of different mosquito species.

* Respondents were not penalized if they indicated there is no *Ae. aegypti* or *Ae. albopictus* identified in the area.

Percentage of vector control programs engaging in routine vector control specifically for *Aedes aegypti* and/or *Aedes albopictus*



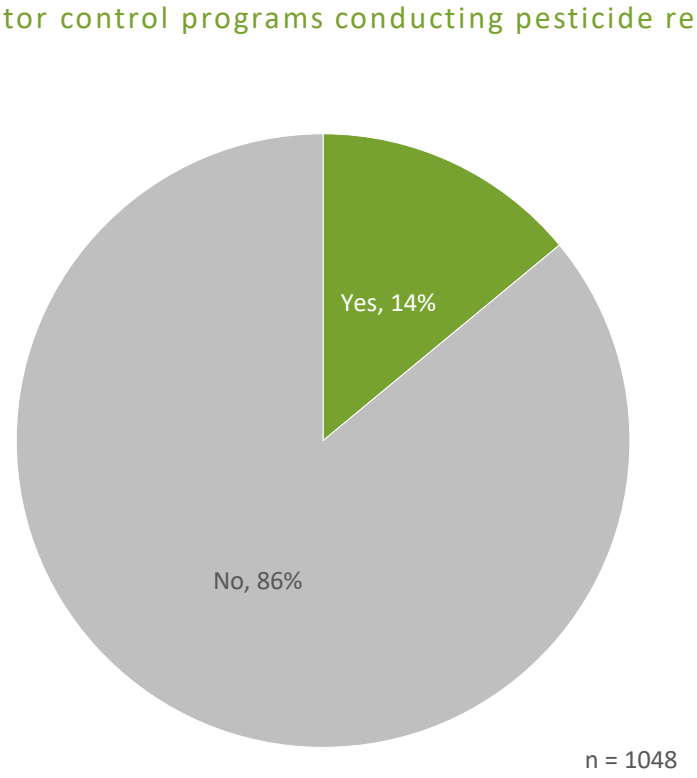
Vector control programs often lack pesticide resistance testing

Pesticides and insecticides are chemicals used to control both larvae and adult mosquitoes. Mosquitoes repeatedly exposed to these chemicals over time can develop resistance.[3]

Pesticide resistance is an overall reduction in the ability of an insecticide to kill mosquitoes.

Of the responding vector control organizations, **86% do not perform pesticide resistance testing.**

To prevent or delay pesticide resistance from developing, vector control programs should include resistance testing, monitoring, and management.[4]



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Supplemental Competencies Performed by Vector Control Organizations

Licensed pesticide use varies among vector control programs across the United States

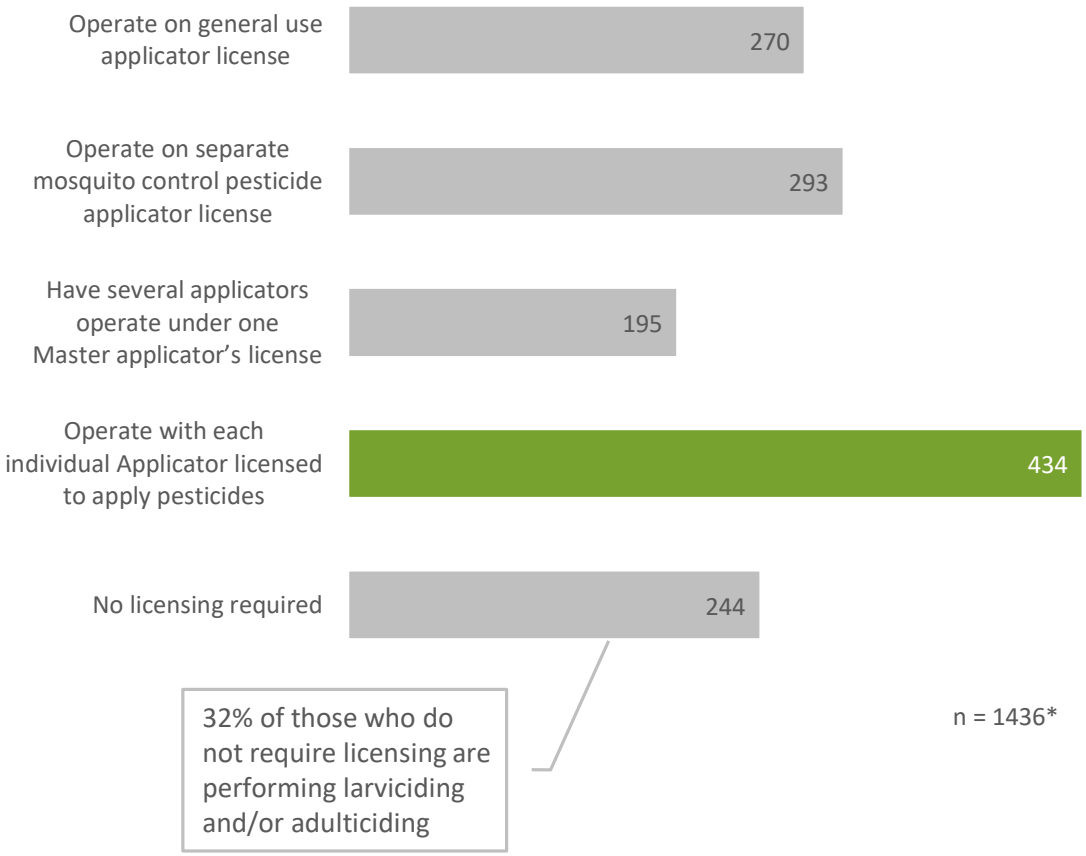
The majority of vector control programs require each operator to have an individual applicator license to apply pesticides.

Licensed pesticide application is one way to ensure that chemical mosquito abatement does not impact other non-target insects, plants, animals, and humans. Licensing requirements can vary by chemical type and state.

32% of programs applying larvicides and/or adulticides require no licensing, yet the assessment did not address their specific licensing requirements.

*Respondents were allowed to select all applicable answers.

Number of vector control programs in jurisdictions requiring licenses for pesticide application*



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Alternatives to chemical control are not universally applied

Alternatives to chemical control of mosquitoes include:

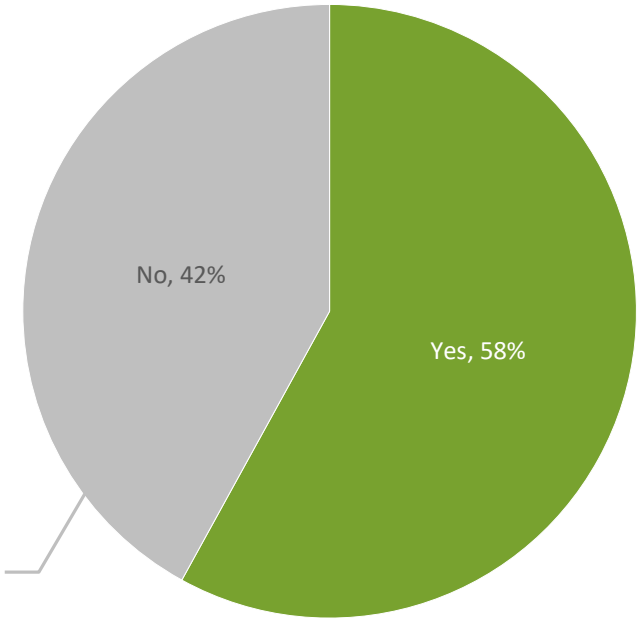
Larval source reduction is the most effective means of vector control. Mosquito larvae develop in standing, fresh water: through environmental modifications you can limit the water sources thereby reducing mosquito larvae.

Biological control entails using biological organisms to manage mosquitoes. These can include: aquatic predators and genetically modified organisms.

58% of programs perform non-chemical abatement activities, 42% do not.

*Of the programs reporting no non-chemical abatement, 56% do not perform any abatement activities, including chemical.

Percentage of vector control programs engaging in control activities other than chemical control



Of vector control programs reporting only chemical control, 4% use larviciding treatment only; 16% use adulticiding treatment only; 24% use both; and 56% do neither.*

n = 1066

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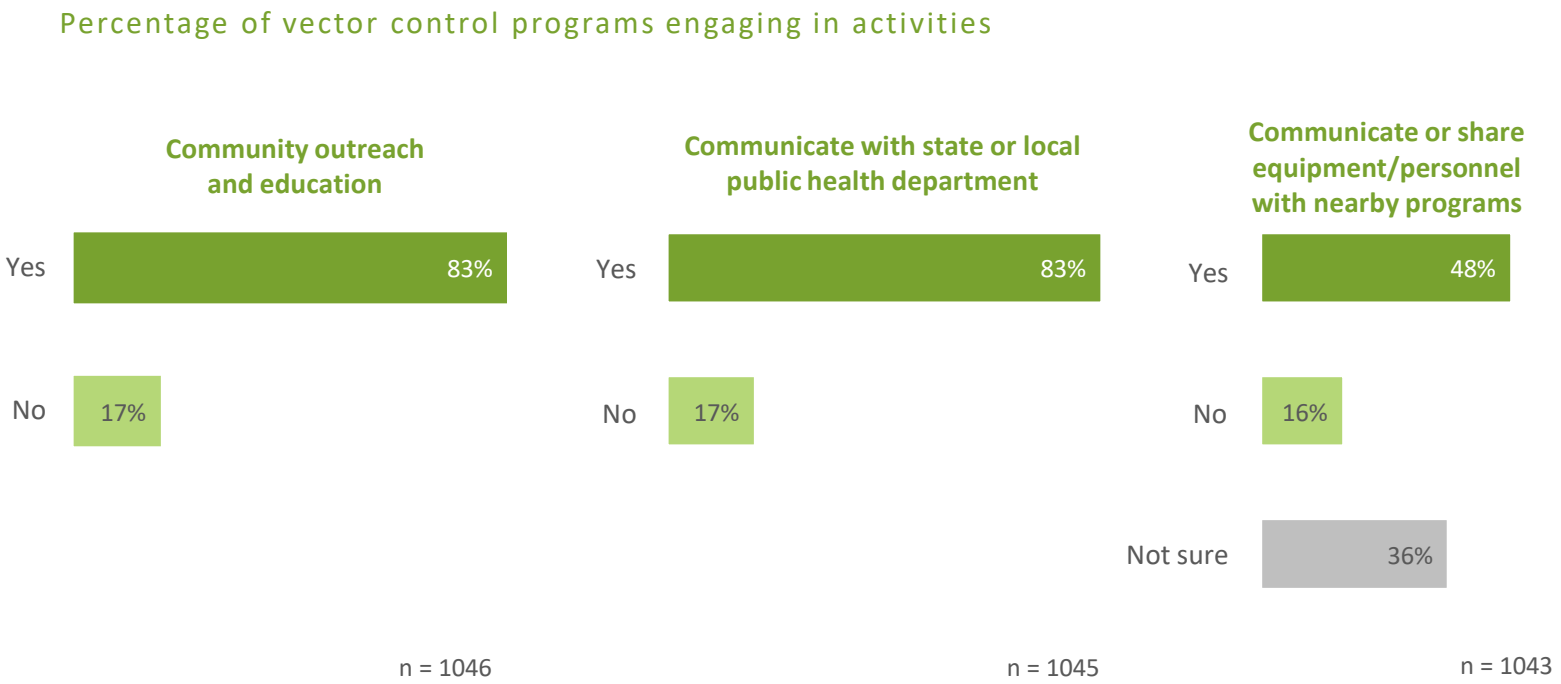
Community engagement and outreach is relatively common among vector control programs

The majority of vector control programs in the U.S. provide **community outreach activities to educate community members** on how to protect themselves from mosquito-borne diseases.

Programs also regularly **communicate with health departments** to receive human surveillance and epidemiology reports.

Nearly half of all programs are willing and able to **assist nearby vector control programs**, an important asset in controlling a disease outbreak.



Competencies among U.S. Regions

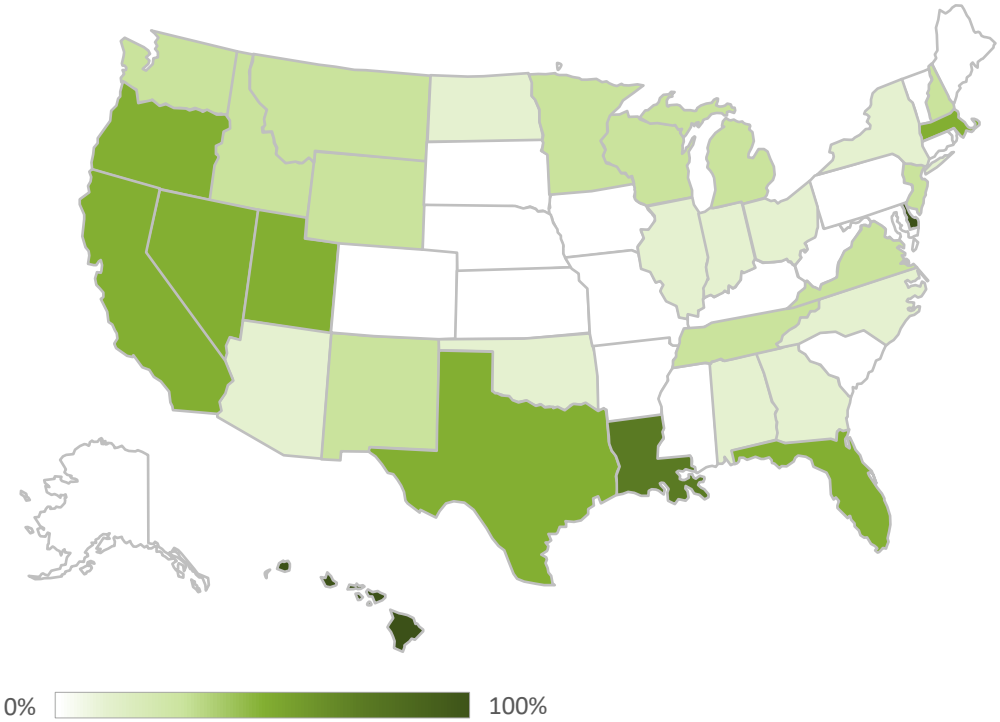
Vector control program competency varies across the United States

If you combine the fully capable and competent vector control programs in each state, the data reveals that **33 states had at least one vector control program meeting all core competencies**. All vector control programs in 17 states were rated needs improvement, indicating none of their vector control programs meet all core competencies.

Critical next steps include:

- **Identifying barriers** to implementing core competencies and
- **Revealing best practices** by fully capable and competent programs.

Percentage of vector control programs ranked as "fully capable" or "competent" by state



Limitations and Conclusions

Limitations and Conclusions

This report describes the first nation-wide baseline assessment of mosquito surveillance and control activities across the U.S. This national report provides comparable data on baseline mosquito control programs to help identify local agencies' preparedness for mosquito-borne virus outbreaks.

A comprehensive understanding of mosquito surveillance and control activities in the U.S. is necessary to identify gaps and needs specific to vector control. As illustrated here, **84% of vector control programs in the country have been identified as "needs improvement"** in one or more core competency.

Reviewing the areas in which vector control programs need improvement can inform decision-makers of the top vector control priorities when allocating resources.

Top Vector Control Priorities:

1. Pesticide resistance testing;
2. Treating based on surveillance data;
3. Routine mosquito surveillance and species identification;
4. Routine, species-specific vector control;
5. Larviciding and/or adulticiding; and
6. Non-chemical vector control (e.g., biological, source reduction, water management).

Challenges and Gaps

Vector control programs are structured and operated differently in each jurisdiction.

Resources, or lack thereof, to support vector control programs was not addressed.

Due to the 57% response rate, the presented responses may not reflect all vector control programs.

Only publicly-funded vector control programs were assessed. Any town or jurisdiction that contracted out services was expected to complete the survey based on the terms of their contract.

Recommendations

Recommendations

Increase mosquito surveillance and control capacity through:

Providing quality and ongoing staff training in standard mosquito surveillance and control techniques;

Increasing awareness of the importance of pesticide resistance testing and the proper training to perform it routinely;

Forming mosquito control districts (34% of mosquito control districts perform all core competencies versus 6% and 7% of local health departments and other organizations, respectively); and

Ensuring sustainable funding and resources are dedicated to local vector control programs to maintain properly trained staff and adequate supplies to perform chemical and non-chemical abatement activities.

Decrease barriers to mosquito surveillance and control competency through:

Identifying the barriers to routine mosquito surveillance and pesticide resistance testing;

Bolster public communication strategies to educate property and home owners on eliminating mosquito breeding grounds;

Supporting data collection and sharing across jurisdictions to monitor mosquito species and density over time and pre-/post-control activities; and

Ensuring all mosquito control decisions are supported by surveillance data with appropriate thresholds.

NACCHO supports federal, state, and local funding for local health departments and mosquito control agencies to provide technical assistance, education, and research to support integrated mosquito management programs designed to benefit or cause minimal harm to people, domestic animals, wildlife, and the environment.

THANK YOU

Acknowledgements

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